

Enhancing Process Safety

Checkweighing in the Pharmaceutical Industry



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1. Introduction

Safety is a multi-layered topic with many aspects to consider along with processes, products, new or already deployed equipment and the personnel working with it. Pharmaceutical manufacturers are always in-between a conflict of increasing productivity while at the same time following safe processes to produce safe products.

This white paper focuses on how to enhance a production facility's process safety with a dynamic checkweighing system in order to meet pharmaceutical compliance requirements, with the aim of producing safe products while staying productive. It looks at how smart software and mechanical features can play a vital role in monitoring and optimizing processes, as well as ensuring reliable and stable product transfers.

The following topics are covered:

- Best practices for checkweighing
- Enhancing cGMP compliance
- Traceability of process changes, record keeping and authorization
- Statistical Process Control (SPC)
- Product Handling
- Communication between the checkweigher and the user's system

2. Dynamic Checkweighing in Today's Competitive Global Pharmaceutical Market

With growing pressure on costs, changing and diversifying markets, the traditional pharmaceutical business is currently undergoing major paradigm shifts. Manufacturing is becoming increasingly technological and software-dependent. Much of production has been relocated to emerging markets and smaller batch sizes and shorter runs have shifted the emphasis from production speed to faster start-up times and easy changeovers. Manufacturers are under pressure to continuously improve their efficiency and optimize the overall equipment effectiveness (OEE) of their manufacturing processes.

In an increasingly-competitive marketplace, checkweighers have become indispensable in helping pharmaceutical manufacturers comply with international regulations and fulfill ever-changing customer needs. Checkweighing is a highly-effective tool for achieving maximum reliability, optimal process efficiency, and a high return on investment (ROI) while delivering safe products, especially when used in conjunction with a well-designed quality control program.

An accurate checkweigher has the capacity to:

- Throughput more safe products in less time
- Detect open flaps and askew packages to protect downstream equipment
- Simplify daily routine processes such as product changeovers
- Increase line efficiency by eliminating false rejects
- Report production data
- Create a platform for other inspection solutions

Pharmaceutical products are important assets to be managed carefully. Unsatisfactory products, such as incomplete packages, must therefore be reliably rejected at all times to ensure they never reach the market and its consumers.

Checkweighers assume the role of an inspector on production and packaging lines and ensure that pharmaceutical products are optimally processed. The integration of other technologies into the checkweighing system, such as optical and marking systems, transform it into a full serialization solution.

As outsourcing and offshoring in pharmaceutical manufacturing continue to rise, quality control and fraud protection will become more complex and challenging. Reliable and traceable safety measures must be taken to prevent poor-quality or manipulated products entering circulation and endangering patients. Today's checkweighers offer a comprehensive set of components and tools to track and document good products and quarantine non-conforming ones through rejection.

3. Enhancing Process Safety and Process Management in Dynamic Checkweighing

3.1 Background: Growing Number of GMP Deficiencies

According to data* made available by the U. S. Food and Drug Administration (FDA) there has been an unprecedented surge in the number of recalls for pharmaceutical products in recent years. The increase is mainly driven by so-called Class II recalls – products which, to put it briefly, "may cause temporary or medically reversible adverse health consequences". Class II already represents approximately two-thirds of the number of recalls; a sizeable number of which are related to current Good Manufacturing Practice (cGMP) deficiencies. cGMP is considered the most important regulation in pharmaceutical manufacturing and establishes the foundation for drug product quality by defining the rules for safe and effective manufacturing of human pharmaceuticals. The consequences of not complying with cGMP regulations can be harsh. This is the process how the U.S. FDA enforces deviations and violations: The FDA documents and communicates concerns in a list of inspectional observations. If the response from the company is not satisfactory, the FDA issues a warning letter listing the major GMP violations. Typically the pharmaceutical manufacturer has three weeks to correct the incidences. If adequate measures are not implemented sufficiently, the FDA may fine the company or even shut down operation and ban or recall all corresponding batches. In very severe cases the agency may even prosecute.

3.2 Designing Processes in Accordance with Regulatory Framework

Regulatory frameworks such as cGMP provide only broad guidance based on general principles. They include, for example, the validation of processes, recordkeeping, operator training and prevention of cross-contamination. It is always the responsibility of the manufacturer to design the production process and quality programs in accordance with the cGMP principles, to interpret the guidelines, and to accurately assess process risks.

Although the wording of the cGMP guidelines issued by the various regulatory agencies on the global stage differs, the underlying principles of equipment implementation and validation are consistent and can be summarized as follows:

- **Equipment Selection** – The manufacturer needs to select the right equipment with suitable weighing ranges and accuracy to meet the defined process tolerance.
- **Equipment Calibration** – Weighing equipment should be calibrated according to written procedures and established schedules.

* Drug Recalls - <http://www.fda.gov/Drugs/drugsafety/DrugRecalls/default.htm> - from FDA

- Qualification and Validation – Weighing systems need to be qualified and weighing processes must be validated to document conformance with defined specifications.
- Validation of Computerized Systems – Advanced weighing systems based on computer hardware and software need to comply with specific regulations for computerized systems.

The manufacturer should define the best method to ensure consistent process quality. The equipment manufacturer must be able to demonstrate, to the inspecting agency, a thorough understanding of its processes and that it has implemented the right measures to fulfil relevant quality regulations. To install and maintain a compliant weighing process, the entire weighing equipment life-cycle must be considered. The lifecycle revolves around customer needs. Prior to equipment qualification, important planning elements of the product lifecycle must be developed and established.

A comprehensive User Requirement Specification (URS) must be written to identify each and every requirement related to the product, including product attributes, safety and quality. Quality Assurance must have involvement reviewing and approving the final list of requirements, and must be an approver of changes to any requirement that can affect the product or process attributes.

A Functional Design Specification (FDS) is prepared by the supplier in response to the URS. The FDS should address all elements of the URS in sufficient detail to indicate how the supplier plans to meet all user requirements. The completed approved FDS will form the basis of design "change control management". As functions and features are added, subtracted or changed from the scope of the design, the URS/FDS should be updated. A Detailed Design Specification (DDS) is generated to fulfill and implement the features that were specified in the FDS.

3.3 Checkweighing: Equipment Qualification for faster Validation Processes

Equipment qualification ensures the accuracy and consistency pharmaceutical manufacturers require in the performance of their checkweighers. Since equipment qualification is integral to the organization and success of pharmaceutical manufacturers, it is important that equipment qualification providers offer robust and complete documentation that follows best practices. As defined by International Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use (ICH) guidance, equipment qualification comprises the aspects of design, installation, operational, and performance qualification.

Design qualification is the documented verification that the purposed design of the equipment or systems is suitable for the intended purpose. The pharmaceutical company needs to define what the checkweigher is supposed to do by specifying the requirements in the URS. Key requirements include the required weighing capacity, process tolerances, and environmental influences.

Installation qualification is the documented verification that the equipment or systems, as installed or modified, comply with the approved design, the manufacturer's recommendations and all user requirements. Installation qualification verifies that the checkweigher is received as designed and specified, that it is properly installed in the selected environment and that this environment is suitable for the operation of the checkweigher.

Operational qualification is the documented verification that the equipment or systems, as installed or modified, perform as intended throughout the anticipated operating ranges. A key element is the calibration of the checkweigher which includes determining measurement uncertainty and minimum weight.

Performance qualification is the documented verification that the equipment and ancillary systems, when connected together, can perform effectively and reproducibly based on the approved process method and specifications. Performance qualification provides assurance that the checkweigher delivers consistently accurate measurements. A defined schedule for routine testing and calibration is essential to ensure and document that the checkweigher is performing as required. The frequency of testing and calibration intervals needs to be based on a risk assessment of the actual application.

Once the equipment qualification is successfully completed, the entire process can be validated. Proper validation reduces the risk of potential fines resulting from non-compliance. When critical components of the checkweigher are replaced or modified a re-validation is required.

Suppliers know their equipment best. It is therefore recommended that pharmaceutical manufacturers ask suppliers first what kind of qualification services they can offer for their equipment. A competent supplier might be the best provider of equipment installation and qualification services. Suppliers can help to ensure regulatory compliance e.g. during FDA audits and reduce risks by providing standardized protocols, written in accordance with Good Testing Practice (GTP) and Good Documentation Practice (GDP) guidelines. A supplier's technicians should possess the product expertise and qualification training needed to qualify and validate the checkweigher flawlessly. This helps pharmaceutical manufacturers to avoid undesirable startup delays caused by labor-intensive and time-consuming tasks, such as generating the documents and performing the qualification.

Reliable solutions-providers offer comprehensive support services, including design, installation, operational, performance, and maintenance qualification. Specially-trained service teams should be able to provide professional immediate qualification and certifications pharmaceutical manufacturers require to document their new checkweighing installations. Standard equipment qualification protocols are already available at the time of equipment installation, so qualification on-site is ready to begin immediately, ensuring that qualification is completed quickly and thoroughly.

Effective ongoing performance verification and maintenance of checkweighers is recommended. Once the validated system has been in use for some time, pharmaceutical manufacturers need to re-evaluate and decide if the equipment is still operating as reliably, effectively, and efficiently as it was originally designed. The ideal supply partner should offer on-site performance verification based on the original user requirement specification. The performance verification service ensures that pharmaceutical manufacturers can rely on a complete equipment configuration and qualification history executed by knowledgeable service professionals.

3.4 In-Process Tests or Reliable and Consistent Testing Procedures

Many pharmaceutical manufacturers have defined internal quality requirements to check that their checkweighing equipment is working correctly. This verification of the checkweigher functionality needs to be done outside of the normal production process. The test procedure to be followed step by step is normally written down on a separate instruction and the results are manually entered on separate documents. Such a testing procedure is very labor intensive, causes operational downtime, and relies heavily on the operator testing consistently every time for reliable results.

In-Process Tests are becoming increasingly common as they significantly reduce the risk of errors during test procedures and are highly flexible to adapt to customers' requirements. They are also easy to operate, generate automatic reports for each test scenario, and most importantly of all require no shutdown of the production. Such tests can be carried out with the help of screen prompts which guide the operator through the complete procedure, and automatically record the results which can be saved and printed. In addition, user-friendly guidance during testing reduces labor time and possible operator errors, enabling manufacturers to benefit from more consistent, reliable results, and higher operational uptime. Furthermore, the system should be capable of setting up several configurable test scenarios.

3.5 Traceability of Process Changes

Pharmaceutical manufacturers need a monitoring system that provides a complete historical record showing what parameter changes were made, who made the changes, and when they were made. A local audit trail offers complete process accountability and compliance with 21 CFR Part 11 requirements. These requirements are enforced and specify that access to electronic systems is limited to authorized users, audit trails must be secure,

computer-generated, and time-stamped to record the date and time of operator entries and actions that create, modify, or delete electronic records. The requirement also specifies that audit trail record changes cannot overwrite previously recorded information, and that records must be retrievable for the retention period established for electronic records.

Checkweighing:

CFR Part 11 compliance in a nutshell

The FDA regulates electronic records and signatures in 21 CFR Part 11 to ensure the authenticity, integrity, and the confidentiality of data. Computerized checkweighing systems can provide several features that ensure correctness of entered or measured data and can make the double-verification principle obsolete. All operations are fully documented and traceable.

It is important to know that a computerized system cannot comply with Part 11, unless the user implements procedural and administrative controls. In addition to the technical controls that the checkweighing system can provide, the user must implement these controls such as trainings and standard operating procedures (SOP).

3.6 Optimizing Process Control

Process control can be optimized by using control charts and Statistical Process Control (SPC).

Control Charts

It is common practice to use statistics to monitor, control and improve process performance by studying variation and its source. Control charts can assist in detecting process variation and can drive process improvements, potentially avoiding the production of non-conforming product. Process improvements can result in more consistent performance, higher quality, lower cost and higher effective capacity.

Control charts for variables monitor characteristics that can be measured and have a continuous scale, such as weight or volume. When an item is inspected, the variable being monitored is measured and recorded. For example, for manufacturing bottles of tablets, weight would be an important variable. Samples of bottles would be taken and weighed. Two of the most commonly used control charts for variables, X-bar and R-bar charts (also see next page), monitor both the central tendency of the data (the mean) and the variability of the data (either the standard deviation or the range). Note that each chart monitors a different type of information. When observed values go outside of the control limits, the process is assumed not to be in control. Production is stopped, and employees attempt to identify the cause of the problem and correct it.

Process Variation

Statistical Process Control (SPC) recognizes that some random variation always exists in a process and that the goal is to control variation rather than individual measurements. SPC is used to determine when to adjust a process and when to leave it alone. The ability to run a process with tight tolerances without producing defective product can be a major advantage.

SPC allows pharmaceutical manufacturers to determine the amount of variation that is common or normal. A control chart can be used to show whether sample data falls outside of the normal range. Upper and lower control limits separate normal from assignable variation. If a sample falls outside the control limits, it is important to look for assignable causes.

An important task in quality control is to find out the range of natural random variation in a process. For example, if the average vial contains 8ml of liquid, we may determine that the amount of normal variation is between 7.7ml and 8.3ml. If this were the case, we would monitor the production process to make sure that the amount stays within this range. If production goes out of this range and vials are found to contain 7.5 ml, this would lead to the conclusion that there is a problem with the process because the variation is greater than the normal random variation.

The second type of variation involves variations where the causes can be precisely identified and eliminated. This is also known as assignable causes of variation such as a machine that needs to be repaired. The variation can be assigned to a particular cause and the problem can be corrected by adjusting the machine.

3.7 Statistical Process Control (SPC) for Increasing Quality, Safety and Reliability

SPC is typically a function of the graphical user interface that uses process data to describe a prototypical manufacturing process in connection with its environment. The goal of SPC is to intervene in the process before tolerance violations occur, and thereby optimize the entire process. SPC is comprised of a group of tools and techniques used to determine the stability and predictability of a process. The method uses a variety of elements that allow pharmaceutical manufacturers to have better control over their processes, to document them and, if needed, to intervene faster thus achieving higher levels of quality, safety, and reliability in their production processes.

SPC records can be generated in printed form, displayed electronically locally, or remotely. Process control is especially useful for the control of processes that demand a high degree of precision, small tolerances and small mean variations, and the use of cost-intensive material.

X-Bar & R-Bar-Charts

A commonly used SPC tool to capture process shifts is X-bar and R-bar control charts.

X-bar measures mean of process, while R-bar measures the range (variation) of the process. A shift in either indicates that the process is out of control so it is important to use both charts to monitor the process. This type of control chart is for quantitative variable measurements, a continuum of values, such as weight.

The upper caution limits (UCL) and lower caution limits (LCL) are derived from standard deviations from the mean. Alternatively limits could be set by functional requirements to stay within a specified tolerance. Often three standard deviations from the mean are used for establishing upper and lower control limits. Upper action limits (UAL) and lower action limits (LAL) can be set more stringently (e.g. two standard deviation from the mean or a 95% confidence interval (CI)) to give early indications that the process might be drifting. Assuming a normal distribution, three standard deviations equates to a 99.7% CI, whereby 99.7% of the values will fall within the UCL and LCL due to normal variation. It can be concluded that values which fall outside this range are due to assignable causes. However, there is a small probability (3% in this case) that a sample which falls outside the limits is still due to normal variation.

This is called a Type I error, where the error is the chance of concluding that there are assignable causes of variation when only normal variation exists. This can lead to falsely rejecting a "good" product and is also known as producer's risk.

A Type II error is where the error is the chance of concluding that there are normal causes of variation when the variation is actually due to an assignable cause. This can lead to falsely accepting a "bad" product and is also known as consumer's risk.

4. Effective Product Handling to Maintain Process Safety

4.1 Why is Product Handling so Important?

Handling products on high-speed production lines presents a myriad of challenges. By identifying the problem areas and investing in appropriate solutions, the benefits and ROI will be immediately apparent.

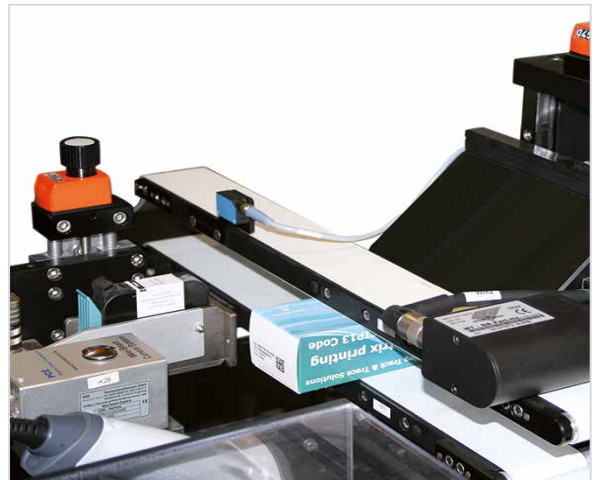
The smooth progression of packages along the line is the ultimate goal, and the more streamlined and efficient this process is, the greater the output that can be achieved. The result is end products being produced cost effectively, without compromising on quality. Any product not running smoothly through the production line will have a negative impact on efficiency.

Meeting the Challenges of High-speed Product Handling

One common issue faced on pharmaceutical production lines is the misalignment of packs as they travel through the process. Allowing askew packages to continue down the line not only results in less accurate weighing but also leads to potential blockages and jams downstream.

Unplanned downtime can have a costly impact on productivity. Checkweighers feature advanced sensors to monitor package orientation, ensuring any askew packages are either rejected or corrected automatically before continuing.

If product is not centered when it reaches the weighing conveyor then accuracy can also be affected. Transversal adjustment is a feature that automatically re-centers product, leading to improved weighing accuracy and better positioning as items continue through production.



The Challenges of Unstable Products

Stability is also a key area of product handling, as taller items with small footprints such as bottles and aerosols are prone to toppling over, leading to unscheduled downtime. It is important that vibrations are kept to a minimum and transition points between conveyor belts are carefully designed to ensure smooth product transfer.

Advanced checkweighing systems offer features that help to reduce or eliminate these issues. For example, side belts are available, which are constructed using precision milled monoblock parts to reduce vibration and stabilize products during weighing, while high-precision crowned rollers optimize conveyor belt guidance to increase product stability.

A separate conveyor and belt specifically for rejects can also help to eliminate possible vibrations caused by rejections, leading to highly-precise and exact product transfer.

Detecting and Rejecting Cartons with Open Flaps

Carton line speeds are increasing and there is always a risk that some will have open flaps, which may damage printing devices, vision systems and sensors downstream if undetected, as well as cause blockages.

Product control options enable pharmaceutical production companies to configure their checkweighers to detect open flaps, rejecting them immediately to minimize disruption. Furthermore, as this is a configurable option, no additional space is required on the line, ensuring manufacturing footprints are as small as possible.

Reducing Downtime Required for Change-Overs
Changeovers can be frequent on pharmaceutical production lines and quick, efficient product changes is critical to maintain production schedules. For maximum process reliability, digital position control is available, which reduces the time spent on component adjustments and automatically controls article changes. The result of allowing this process to be controlled digitally is error-free product changeovers, which leads to reduced waste and costs as the machine can only be started when all relevant parameters have been correctly adjusted.



Detecting and rejecting askew packages

Checkweighers have a pivotal part to play in pharmaceutical production and by investing in advanced checkweighing systems with the capacity to handle products efficiently, pharmaceutical manufacturers can maximize uptime, increase productivity and ultimately improve profitability.



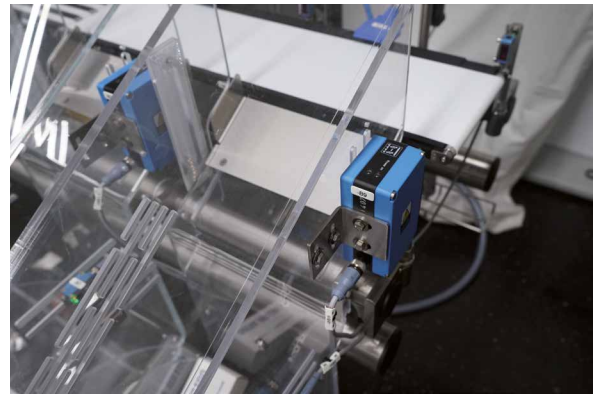
Detecting and rejecting open flaps

4.2 Isolating from the Environment

Checkweigher systems should not be installed in areas that are subjected to or near vibration and mechanical shock. Every effort should be made to minimize such effects.

Machine isolation

Checkweighing equipment should be isolated from any vibrations. Vibration can come from nearby traffic, other machines such as presses, or from contact with other conveyors. The checkweigher must never be mechanically connected to other machinery. To combat vibration, checkweigher structures should be fully welded, with properly balanced rollers and pulleys. Isolated weighing sections from the checkweigher itself can also enhance performance.



Sensors keep track of all packages on the checkweigher

Electrical isolation

Product inspection systems should be supplied with steady, transient-free electric power. To minimize power fluctuations, the source for the inspection device should be a dedicated line, and not used to power other machines.

Electromagnetic

Product inspection equipment is designed with care to prevent the emission of electromagnetic waves, and to prevent the influence of nearby electromagnetic fields. Pharmaceutical customers should verify that the equipment supplier has complied with the relevant Directives and standards for this area. These include The EMC Directive and EN 61000-6,2,3,4. Suppliers should be ready to describe shielding and grounding practices, and testing performed to verify the insusceptibility of the machine, and the level of interference possible from the machine.

As the verification tests are done with a certain enclosure and internal components, the user should never place unapproved components or conductors in the control enclosure, as this can compromise the integrity of the shielding and grounding.

Electrostatic

Static charge is accumulated on the surface of an item when there is friction between two dissimilar, non-conductive materials. This can be from a belt moving over a plastic conveyor bed or from a package moving on a belt. The accumulated charge can reside on the package, or on a housing for the machine. As checkweighers are so precise, the small amount of force between two electrostatically-charged parts can lead to a weighing error. The electrostatic effects with the product can be defeated with an ionizer, and the surface charge on a housing can be eliminated with a conductive surface that is grounded.

Draughts

Protection from air currents by use of draught shields is also recommended around highly-sensitive checkweighers. Draught shields can be separate structures, or an integral function of a larger, full enclosure of the machine. Draughts typically come from overhead fans, but more sensitive machines can be affected by air currents at the floor surface, or by currents caused by nearby traffic.

Vibration compensation with adaptive filtering

Advanced load cell modules should provide adaptive filtering to compensate for external disturbance sources such as vibrations from machinery or local conditions. This of course without compromising quality in terms of accuracy and throughput.

4.3 Accounting for the Product

Pharmaceutical manufacturers take great care to ensure only product is shipped that is intended for shipment, and that no product leaves the production line without knowing where it went. Modern checkweigher systems commonly provide tools to account for each package that enters the checkweigher by using sensors before the scale area and on the outfeed of the checkweigher. The checkweigher keeps track of the package on the belts with an intelligent drive system and can identify any product that is removed from the conveyors or inappropriately inserted in the line.

Products that are identified as faulty must be removed from the stream of good products. The user must also ensure the rejected product enters the reject bin. This is generally referred to as reject confirmation. The simplest approach is a photosensor that scans the entrance to a reject bin or other collection device. Scanning can be improved with light curtains if the trajectory of the product is not consistent (e.g. light cartons rejected with an air jet).

4.4 Product Registration

"Registration" is a term used to quantify the positional characteristics of one feature, relative to standard positions. Three types of product registration are discussed here: centering, orientation, and pitch. Ninety-percent of checkweighing is good package handling.

Centering

Most checkweighing systems will weigh accurately, regardless the position of a product across the scale. When a product becomes off-center, or eccentric, the package transfers can be a bit different, and the weighing can have additional, unnecessary variation. Products that are eccentric are also more likely to jam, are more difficult to consistently reject, and more difficult to transfer. Guides and side grips are tools that make product centering more reliable and reduce product handling issues.

Misorientation

Products that are improperly oriented (askew, or with a slight rotation) can seem longer to the checkweigher than they actually are, and this can compromise weighing performance. A product with even a small amount of rotation can be an issue with downstream guides, be difficult to reject, or transfer poorly. Any of these can lead to a jam and a stopped line. The sooner the fault is detected, and the product is removed from the product stream, the greater the OEE of the line. Tools are generally available to assess the orientation of a product, and then to remove the misoriented product from the production line.

Spacing between packages

Exact and uniform package spacing is a key factor in achieving accurate weighing results. The ideal is when the products are at perfect pitch, i.e., there is a consistent distance from leading edge to leading edge of products, and the distance is closely related to the length of the weighing conveyor. Pitch consistency is improved when product is delivered consistently to the checkweigher. This provides the best change to accelerate the product to the required pitch, without excessive gap, and excessive speed. Top and bottom assemblies, and side grips can also assist in properly delivering products consistently, as well as provide smooth transfers.

With round products such as bottles or canisters, timing worms can be used to provide the required pitch. Timing wheels, or starwheels can be applied to consistently time the product, before it is accelerated with side grips or other conveyors.

4.5 Securing Product Reject Bins

Reject bins should be designed to withstand the environment where they are applied, and for the type of product they are used to collect. Normal materials are polycarbonate and stainless steel. Reject bins should also provide a level of security for the product inspected, and for the personnel involved in the process. The least secure is a reject bin with a simple, tool-free latch. A moderate level is a reject bin with a latch that requires a tool or key to access. The most sophisticated approach is a reject bin that uses electromagnetic latches that secure the pin, and can only be unlocked by an authorized user through a user-interface password. This is an automatically recorded event, i.e. traceable.

Reject bins can also be fitted with sensors that detect a "full" condition, and provide an alert to the operator or other personnel to clear the bin and record the transfer of materials. This can be further improved with an additional sensor that identifies "almost full" before the "full" condition, to make better use of resources.

4.6 Communications: How Inspection Data are Used in the Process

The more evolved the production line, the more important the communications between the checkweigher and the user's control system. Data communication is usually seen across four levels in the ISA 95 structure. This starts at the machine level, and extends all the way up to MES and ERP. At the line control level, the operation needs to be able to communicate with other machines and with the line control PLC. The checkweigher should have a complete set of data it can communicate bi-directionally with the line-PLC, and these are normally done with Fieldbus interfaces such as Profibus, Modbus, and Ethernet IP. The checkweigher should be able to communicate its production results, including the total throughput, number of product faults, package weights by zone, averages, and standard deviation for the production run. More capable communications solutions enable product management and product change remotely from the PLC. The most capable provide machine-state communications following ISA TR 88.00.02 (PackML). PackML communicates all forms of machine state (stopped, e-stopped, executing, starved, etc.) in a manner that is common to all packaging machines. PackML tags provide data on the specific states and time in those states, which can be used as immediate inputs to calculate OEE.

The checkweigher supplier should also have experience of working with different "middleware" solutions, to advise the user on the most appropriate communication tool for the application.

Data collection and quality systems are also available for product inspection equipment. These are easiest to implement as the interfaces are pre-defined, and no software or integration work is required by the user. Such systems can also deliver data upstream to the user's control system.

The goal should always be to have the communications available at the process line level to react to line conditions and, at the same time, deliver data to the higher levels to manage material requirements and have visibility of the overall production picture.

4.7 Equipment Safety

Equipment safety is a shared responsibility between the supplier, the user, and the user's system integrator. Open discussions about inherent risks, safety measures applied, and residual risks transferred to the user should be welcomed. The equipment supplier should be willing to freely discuss the safety process used in the design of the machine, and the results of the risk assessment. The supplier's hazard-based risk assessment is a valuable starting point for the user's task-based risk assessment. The supplier should provide a Declaration of Conformity (CE Mark), or any third party qualifications for the equipment. In the EU, it is the responsibility of the equipment supplier to provide that Declaration of Conformity, and it is also the responsibility of the user (or the user's integrator) to provide a Declaration of Conformity for the production line (assembly of machinery). These are required by the Machinery Directive.

A thorough safety process will consider:

- Risk assessment
- Safe mechanical design practices
- Safe electrical design practices
- Safety circuit, in accordance with ISO 13849
- Safe integration practices

4.8 Avoiding Serial Faults with Smart Software

Numerous tools are available to diagnose process faults and misadjustments. Many users take advantage of the checkweigher's ability to recognize recurring rejects as indications of upstream problems.

Two modes of pattern recognition are most common:

- Identifying a continuous series of rejects (consecutive faults), as "n" in a row to identify a major fault in the process.
- Identifying a pattern of rejects, such as every "nth" package, can indicate an intermittent fault in the process.

An example of a consecutive fault could be open flaps if a cartoner is not properly gluing the flaps upstream from the checkweigher. An example of a pattern would be a blocked fillhead or gassing unit. With a 12 head filler if one of the heads is blocked the fault will occur every twelfth product. Setting a pattern threshold where two faults out of thirteen occur will identify the blocked head.

Table 1 shows examples of typical faults and how they would be communicated.

Error message	Alarm notification	Probable Cause	Checkweigher Action	Light signal response
Overload	HMI	Beyond scale capacity	Weight display is *** Package rejected	Amber – permanent
Exceeded threshold for consecutive rejects	HMI	Exceeded threshold for consecutive rejects	Reject packages. Conveyors stopped	Red – permanent
Product backup	HMI	Downstream jam	Conveyors stopped	Red – permanent

5. Advantages of Integrated Pharma Solutions

The need for advanced system solutions in the areas of quality assurance, checkweighing, serialization, and track & trace is not only the result of legal requirements, but also of the ever-growing demand for quality and traceability in pharmaceutical and medicinal products. The advantages of a complete solution include its simple integration into the production line and the knowledge that all the components are guaranteed to work smoothly together. Complete solution suppliers also offer a single point of contact for service and support.

The decision to opt for a complete-solution supplier offers the following advantages

- One point of contact for all systems concerned
- A single supplier of components rather than several different ones
- Compatibility of components
- Combined systems are more compact, allowing easier line integration, and have fewer moving parts, thereby reducing maintenance time and cost
- Reduction of user interfaces minimizes operation errors, makes product changeovers faster and more efficient and increases operational uptime

Introducing any new piece of production line equipment can negatively impact OEE. To prevent this, pharmaceutical manufacturers must be careful to choose equipment suppliers who are competent at processing difficult-to-handle products at high throughput rates. Any unnecessary downtime of the production line should be avoided by all means. Pharmaceutical manufacturers are advised to search for solutions which are capable of combining high throughput rates with high conveyor speeds. This will enable them to maintain current throughput levels, to integrate serialization and offer scope for future speed increases. Production line equipment suppliers should understand OEE and be able to supply solutions which will not negatively affect it.

When selecting a suitable equipment supplier, the priority should be finding a checkweighing solution which offers the following performance features:

Performance features	Advantage for customer
Stand-alone range through to all-in-one solution (weighing, marking & vision)	Simple and space-saving line integration
Optimum production flow	Exceptional reliability thanks to perfectly coordinated system components
Integrated data flow	Potential for total integration into existing ERP systems for a seamless, automated data flow
CFR 21 Part 11 conformity	Total traceability, archiving, audit trails and documentation as proof of validation
Various printing technologies	Inkjet printing, laser marking
High throughput	High throughput for weighing; quality, and future-proofing for investment protection
System qualification	High-quality, individual validation and qualification documents
Optimum product handling	Secure and reliable product handling, ensuring the highest-quality weighing

6. Factors to Consider When Choosing a Solution Partner

When selecting an equipment supplier, the following factors should be taken into consideration:

Level of information – Does the supply partner know and monitor the current regulatory requirements in various countries? This could be decisive for ensuring the required functionality of the solution. Moreover, having a valued partner will be beneficial in terms of long-term strategic initiatives.

Integration know-how – Is the supply partner able to deliver solutions for established components and technologies already present in the production line? This would considerably reduce integration costs and the timescale.

Competence – Is there any proof that the supplier will be able to deliver the required performance, including in the long run? Is the partner capable of implementing an international roll-out?

Stability of resources – Does the partner have the financial stability and resources to meet short-term requirements and to provide value-for-money service in the long term? Is the offered software and hardware solution modular and scalable for future applications?

Efficiency of service – Does the partner offer a global service with strategically located support able to provide a rapid on-site response when needed?

Capabilities – Are the solutions offered by the supply partner flexible enough to integrate with existing software and hardware, including the possibility of easy integration with new technologies, and evolving requirements? Does the partner have a proven track record in carrying out projects professionally and without delay, including in an international context and on a large scale? Is the supplier able to think outside "their" box, offer a full range of product inspection equipment and ideally know how to combine them in clients' applications?

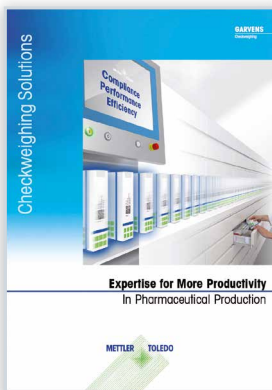
Checkweighing solution suppliers should provide an optimum combination of its system components. Many years of experience in the development of checkweighing systems for the pharmaceutical industry are necessary to support pharmaceutical manufacturers by fulfilling all legal requirements for pharmaceutical products and, in doing so, provide protection for brands and customers. Equally important is a global sales and service network to handle worldwide enquiries.

Further Useful Information

For more information on checkweighing for pharmaceutical manufacturers please visit
 ► www.mt.com/cw-pharma where you will find:



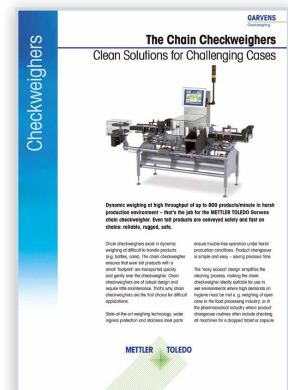
- Checkweighing brochure "Achieving Higher Productivity in Pharmaceutical Production with Checkweighing Expertise" detailing the optimum inspection solutions
- Guide "Performance Optimization Guide for the Pharmaceutical Industry" explaining the crucial software and mechanical options for safe and reliable production processes
- Checkweigher data sheets of various advanced checkweigher solutions pre-configured with typical "pharmaceutical" functions and features
- Videos of applications in pharmaceutical production demonstrating how to benefit from checkweighers' mechanical and software features



Checkweighing brochure "Achieving Higher Productivity in Pharmaceutical Production with Checkweighing Expertise"



Guide Performance Optimization Guide for the Pharmaceutical Industry



Product data sheets Performance Optimization Guide for the Pharmaceutical Industry



Application videos Checkweighers' mechanical and software features

About Mettler-Toledo Product Inspection:

The Product Inspection Division of METTLER TOLEDO is a leader in the field of automated inspection technology. Our solutions increase process efficiency for manufacturers while supporting compliance with industry standards and regulations. Our systems also deliver improved product quality which helps to protect the welfare of consumers and reputation of manufacturers.



Metal Detection



X-ray Inspection



Checkweighing



Vision Inspection

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